Understanding Iliotibial Band-Sparing Total Hip Arthroplasty: Alternatives to Traditional THA Approaches

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Abstract

Excellent long term results in total hip arthroplasty (THA) are achievable through a variety of surgical techniques. However, the push for cost savings and higher patient expectations has shifted the focus to improving short term outcomes such as length of stay and in-hospital narcotic requirements. While approximately 87% of surgeons worldwide continue to prefer traditional posterolateral (PL) or lateral approaches for arthroplasty, [1] alternative approaches that spare the iliotibial band have emerged over the last several years in hopes of improved outcomes. This review explores the iliotibial band-sparing approaches, their advantages and disadvantages, and provides an overview of their published results.

The Iliotibial Band

The Iliotibial band (ITB) is a group of vertically oriented fibers consisting of a superficial, intermediate and deep layer that converge from their origins at the iliac tubercle, iliac crest and the superior acetabulum and insert on the lateral femoral condyle and tibia. Huang et al, who dissected 40 cadaver specimens and examined the ITB and investing structures at the hip, describe the insertion of the superior fibers of the gluteus maximus as a posterior reinforcement of the ITB. [2] These fibers do not insert at the greater trochanter, but rather join the continuation of the tensor fascia latae and the remaining fibers of the inferior gluteus max-

imus to insert at the linea aspera via the lateral intermuscular septum. [2-4] (FIGURE 1)

Much study and emphasis has more recently been focused on the function of the ITB at the knee, where it functions to create a rigid support pillar to allow for asymmetric standing. [3-5] However, Inman attempted to qualify and quantify its contribution to standing and gait at the hip as early as 1947. He proposed that the ITB provides nearly half of the torque necessary to keep the pelvis level

Figure 1: Approximately 75% of gluteus maximus insertion is into the iliotibial band. Image courtesy of dept. washington.edu

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Level of Evidence: AAOS Therapeutic Level V

and is one of the final restraints to prevent further sagging when the pelvis is allowed to sag unilaterally. [6] The result of disrupting this checkrein to hip abduction during single leg stance has been shown in literature evaluating lateral THA approaches, with the incidence of Trendelenburg gait as high as 31%. [7]

Direct Anterior Approach

The Direct Anterior (DA) Approach is the most popular and studied of the ITB sparing approaches. The intermuscular, internervous interval of the approach, with the plane extending between the tensor fascia latae (TFL) and the sartorius muscles, was originally described in 1881 by Hueter, [8] and subsequently modified by Smith-Petersen in 1917. [9] It was not routinely used in THA until 1980 when Light and Keggi published their results, which showed a low complication rate, although average length of stay (LOS) was 12.8 days in their study. [10] Over the last 20 years, renewed interest in the DA approach has been driven by the search for a less invasive approach with faster recovery.

The DA approach can be performed using either specialized tables or a standard operating table, depending on surgeon preference. Specialized tables allow traction boots to be used and may allow for more precise positioning and control of the extremities during the surgery. When using a standard table, a bump may be placed beneath the patient at the level of the anterior superior iliac spine (ASIS) to allow relative extension of the hip to allow for better exposure during femoral preparation. In addition, the table itself can be flexed in a way to allow for additional hip extension if the patient is positioned at the crease of the table.

While placement of the incision may vary slightly with surgeon preference, it generally extends from approximately 3 cm inferior and 3 cm lateral to the ASIS, extending distally over the TFL muscle belly. Dissection of the fascial planes of the TFL is carried out to ensure proper muscular intervals and avoid medial dissection near the femoral neurovascular bundle. After separating the TFL from the sartorius, the TFL is retracted laterally, retractors are placed extracapsularly over the superior and inferior femoral neck as well as the lateral edge of the intertrochanteric ridge. (FIGURE 2) The fat overlying the anterior hip capsule is removed, and the attachment of the reflected head of the rectus femoris is released from the anterior acetabulum. Capsulotomy or capsulectomy is then performed and the joint exposed by placing the retractors intracapsularly. The femoral neck cut is made and the head is extricated. The acetabulum is then prepared and the cup placed, often-

Figure 2: DA Approach superficial dissection is performed between TFL and sartorius. Image courtesy of Dr. Aaron Salyapongse

times under fluoroscopic guidance to ensure proper positioning. The femoral shaft is then presented by extending, external rotating and adducting the hip. Specialized bone hooks and offset broaches have been designed to assist in presenting the femur out of the incision. [11] Early teaching of the technique also described a release of the posterolateral capsule at the greater trochanter to allow for further translation; however, several authors now recommend releasing the conjoint tendon to the level of the obturator internus and, when necessary, the piriformis, to facilitate adequate exposure. [12-14] After femur preparation is complete, trialing, final implantation and stability testing takes place. The wound is closed in the standard fashion. While individual protocols vary, many DA surgeons do not place formal restrictions on mobility for their patients postoperatively.

Outcomes of the DA approach have been favorable, particularly in the early postoperative period. Barrett et al performed a randomized trial comparing DA and PL approaches performed by the same surgeon. The DA patients had less pain, were discharged sooner, and were able to walk greater distances during the first and second postoperative days in comparison to the PL approach patients. However, the longer-term outcomes were equal at 6 months between the two groups. [15] Restrepo et al performed a randomized study comparing the DA and direct lateral (DL) approach and had similar improved short term outcomes in the DA group. [16] Berend performed a large retrospective study comparing the DA and the less-invasive DL approach. The LOS between the groups was not significantly different, but the percentage of patients discharged home, the Harris Hip Scores and Lower Extremity Activity Scores were all significantly higher in the DA vs. the DL group. [17] Several studies support these findings,

[18-22] while others refute them. [23]

Initially described and advertised as a “tendon sparing” approach (focused on sparing the short external rotators (SER) in comparison to the posterolateral approach), releases of the piriformis and conjoint tendon better facilitate femoral preparation during the DA approach. [12-14] Meneghini performed a cadaveric study comparing muscle damage incurred by DA and PL approaches and reported that release of the piriformis and conjoint tendon was necessary in 50% of their dissections in order to achieve adequate femoral exposure. [14] This, however, does not appear to compromise the potential for accelerated recovery. Rodriguez et al compared 60 patients that had the DA approach THA using a release of the posterior superior hip capsule, the piriformis, and the superior portion of the conjoint tendon to 60 patients who underwent THA using the mini-incision posterolateral (PL) approach. The patients who had the DA approach had faster return to function in the early postoperative period compared to the PL group, consistent with other reports on the DA approach that do not explicitly describe these tendon releases. [13] This suggests that the DA approach’s preservation of the SERs may not be the main factor contributing to accelerated recovery, [24] but may instead be the preservation of the ITB.

The DA approach is not without risk of intraoperative and postoperative complications, especially in the operations performed in the learning curve period. [25,26] While relatively rare, the most common complications include intraoperative femoral fracture or perforation, acetabular fracture, lateral femoral cutaneous nerve (LFCN) palsy, and dislocation. Ankle fracture has also been reported with the use of traction tables for positioning. [27] Because of the location of the incision, superficial wound complications are also an issue, especially in patients with higher BMI. [28] These complications are more common (as high as 9-13%) [29] in the first 50-100 cases, designated as the learning curve, [26,29-30] with early revision rates as high as 6%. [30] These complication rates appear to decrease according to surgeon experience, with complication risk profiles similar to that of other hip approaches after the learning curve. [21,31,32] Additionally, risk of complications and expertise required both increase when using the DA approach for complex or revision cases, although it can be successfully performed. [33] The risk of an increased rate of these complications during the learning curve as well as the decreased extensibility of the approach remain deterrents for some surgeons to pursue the potential improved short term outcomes afforded by the approach, especially when long term outcomes have not been proven to be significantly better. [17,34,35]

SuperCap® / Direct Superior Approach®

In 2002, Dr. Stephen Murphy first described the Supercapsular THA (SuperCap® Microport Orthopedics Inc., Arlington, TN, USA). This single-incision technique shifts the traditional posterior superficial dissection slightly proximal, preserving the ITB at the greater trochanter (FIGURE 3). Other modifications have been introduced (Direct Superior® Stryker Inc., Kalamazoo, MI, USA), but share in common the use of a superior capsulotomy and specialized instrumentation in an effort to avoid releasing the SER tendons.

Patients are placed in the lateral decubitus position on a standard operating table. The operative leg is placed in flexion, internal rotation, and adduction by placing the foot on a Mayo stand. The incision is typically in line with the femoral shaft just superior to the greater trochanter, extending proximally between 6-8 cm. Blunt dissection is performed to split the gluteus maximus in line with its fibers until the interval of the posterior border of the gluteus medius and the piriformis is identified. The piriformis and conjoint tendon attachments are preserved, if possible. Alternatively, the Direct Superior® or Northern approach uses the traditional PL approach deep interval (between the gluteus medius and the conjoint tendon with release of the piriformis and superior SERs) with the same ITB-sparing superficial dissection. [36] The gluteus minimus is reflected anteriorly from the superior capsule and the capsule incised along the superior aspect of the femoral neck, extending to the acetabulum.

Retractors placed along the anterior and posterior femoral neck allow complete visualization of the proximal femur. The proximal femur is prepared in line with the femoral shaft with the femoral head and neck in situ. This

Figure 3: ITB-Sparing techniques: all superficial dissections do not violate ITB tendon. Image courtesy dept. washington.edu

theoretically distributes stresses during femoral preparation, decreasing the risk of intraoperative femur fractures, and avoids overstretching the attached short external rotators that occurs with surgical dislocation. Acetabular preparation is performed using specialized instrumentation in the form of angulated reamers (FIGURE 4) and offset cup

Figure 4: Angled reamer used to avoid violation of ITB tendon.
Image courtesy Dr. Brandon Gough

inserters, with or without the use of CT guided navigation to aid in positioning. While these instruments are required for preparation of the bony structures, any implant system can be inserted during the procedure. The capsulotomy is closed in a normal fashion after trialing, implantation and in-situ reduction, and the piriformis insertion, if released, is repaired. Closure of the remaining layers is performed in the standard fashion. [37]

The tissue-preserving nature of the superior approach affords the stability of the traditional transgluteal approach while decreasing the potential risk of gait abnormalities and pain associated with the traditional posterior approach, presumably by preserving the ITB. This allows patients to routinely be placed into an accelerated rehabilitation protocol, permitting them to bear weight almost immediately after surgery without traditional hip precautions. [37,38]

In a study of 218 consecutive patients undergoing total hip arthroplasty using this technique in 2010-2011, 87% of patients were discharged within 2 days of surgery, and 99% of all patients were discharged home, with only 1 re-admission for a GI bleed related to use of NSAIDs postoperatively. There was only 1 reoperation at 8 months postoperatively, an irrigation and debridement for continued pain with no evidence of infection. [38] Capuano reported on 463 patients including 275 primary elective THA and 188 femoral neck fracture patients that underwent THA using this technique. 375 patients (75%) could walk with full weight bearing on the operative leg within 6 hours of the procedure. There was a 1% complication rate (1 dislocation, 2 malpositioned cups, 2 loosened cups), all within the first 20 cases. There were no further complications reported after the first 20 cases. [39]

PATH®

First reported by Dr. Penenberg in 2004, PATH® (Microport Orthopedics Inc., Arlington, TN, USA) utilizes the deep interval of the traditional PL approach, but differs from the traditional approach by shifting the superficial dissection superiorly to avoid disruption of the ITB at the greater trochanter. Rather than using an angulated reamer of SuperCap®/Direct Superior®, acetabular reaming is accomplished by inserting a cannula through a portal in the soft tissues just posterior to the proximal femoral shaft, avoiding the ITB at the trochanter. This allows for direct visualization of the acetabulum during reaming, as well as the use of straight reaming handles for more familiar reaming control.

The patient is placed in the lateral decubitus position on a peg board, anterior on the table with the foot on a Mayo stand to allow for flexion, adduction and internal rotation of the leg. The incision starts at the proximal edge of the greater trochanter and extends proximally, angled 30-45 degrees posteriorly. After incision of the overlying fascia, the gluteus maximus is bluntly dissected in line with its fibers. The interval is developed between the gluteus medius and the conjoint tendon. The piriformis insertion is identified and it is released along its footprint, preserving as much length as possible for later repair. If necessary, the superior portion of the conjoint tendon may also be released for increased exposure. A posterior capsulotomy is performed, in line with the femoral neck, to the level of the acetabular rim before it is curved anteriorly along the posterior wall toward the lateral rim, creating a “J-shaped” capsulotomy. In the originally described approach, the hip was dislocated to allow for the femoral neck cut. However,

in recent years, modifications (PATH II) allow for the femoral neck cut to be performed in-situ. Intracapsular Hohmann retractors are placed anterior and posterior to the femoral neck cut to expose the osteotomy site and protect soft tissues. A napkin ring of bone is typically removed as proximally on the neck as possible to facilitate head extrication, or, depending on surgeon preference, a single osteotomy with en bloc extrication may be performed. With a more posterior capsulotomy, a small (3-4mm) corner of the posterolateral greater trochanter without muscular attachment may impede the femoral neck osteotomy at the appropriate angle. This small piece of bone may be removed via cheilectomy to facilitate the osteotomy.

The hip is then slightly flexed and maximally internally rotated and the femur is prepped and broached. Once broaching to the appropriately sized implant is completed, a “cleanup” neck cut is performed using the inserted broach as a cutting guide. The appropriate depth and angle of the neck cut is determined by referencing the distance between the shoulder of the broach and the tip of the greater trochanter and comparing to preoperative templating. This allows for reliable and reproducible implant positioning.

The leg is then returned to the starting position for acetabular preparation. Large Hohmann acetabular retractors are used to provide visualization. A cannula is introduced through a downstream portal using an over-the-top guide, using the native acetabulum to direct placement. The cannula is directed through the soft tissues posterior to the femur and towards the acetabulum. Once the cannula is in place, an 8mm reamer driver is inserted into the cannula and the reaming basket inserted and assembled in situ through the main exposure to perform reaming under direct visualization (FIGURES 5,6). The acetabular component is then inserted and impacted into a position of stability, with full visualization of the bony rim and cup during the insertion. Trialing is completed, intraoperative x-rays may be taken, range of motion and stability is tested, and final implants are inserted. The posterior capsule, piriformis and conjoint tendons are then repaired and the incision closed in the standard fashion. [40]

Penenberg reported on 250 consecutive patients, without excluding patients for BMI or complexity, and followed them for two years. All patients were placed into an accelerated rehabilitation protocol, and 83% of patients were using a cane or no assistive device for ambulation at discharge. There were no dislocations, infections, or deep vein thrombosis in the group. Femoral and acetabular components were within the accepted limits in 96% and 97% of patients, respectively. [40]

Rasuli and Grofton analyzed the learning curve of the

Figure 5: Small posterior incision and accessory portal with cannula in place allows for reaming and impacting cup without violation of ITB

Figure 6: Cannula provides excellent in-line access to reamer basket without violating ITB and with minimal release of piriformis and external rotators

PATH procedure, showing reproducible acetabular anteversion and abduction (13.1 ± 7.1 degrees, 42.9 ± 7.6 degrees), mean operative time of 114 minutes, and 2 complications in the first 50 cases (intraoperative femoral fracture in case 10 and a posterior dislocation at 6 weeks in case 26). [41] This relatively short learning curve demonstrates the safety of the procedure, likely due to the familiarity of the dissection to trained surgeons, while still affording the benefit of accelerated recovery after surgery. In addition, the incision and intervals are extensible and easily convertible to the standard posterior approaches.

SuperPATH®

Developed by Dr. James Chow, the SuperPATH® (Mi-

croport Orthopedics Inc., Arlington, TN, USA) approach is a combination of certain aspects of the SuperCap/Direct Superior® and PATH® techniques, using the interval, capsulotomy, and femoral preparation of the Superior approach, but using the cannulated portal and straight acetabular reaming instruments that PATH® introduced. [41] The patients are similarly placed in the lateral decubitus position on a peg board, with the patient anterior on the bed to allow for a flexed, adducted, internally rotated position of the operative leg. The incision and dissection of SuperPATH® are similar to SuperCap®, with the interval between the gluteus medius and the piriformis being developed and attempted preservation of the piriformis and conjoint tendon insertions. After the capsulotomy is performed in approximately the 11:00 position, the femur is prepared in situ by “canoeing” a space into the femoral neck to allow for subsequent broach placement. The final broach is left in place for the femoral neck cut, similar to the technique described in PATH®, using the distance between the broach shoulder and the tip of the greater trochanter as a reference. The head is removed en bloc. The acetabulum is then prepared in a similar fashion to that described above in the PATH® approach. Once trialing is completed and final implants are placed the hip is reduced. Stability and range of motion is tested, and the capsule and soft tissues are repaired before standard closure is performed. [42]

This approach was developed to allow for the perceived advantages of the each of its predecessors, preserving the iliotibial band and external rotators, with in-line axial femoral preparation prior to the femoral neck cut as in the SuperCap® approach and allowing for consistent acetabular reaming through the accessory portal as in the PATH® approach.

Results of the combined technique are similar to the other “micro” approaches. Chow et al reported on the first 110 patients, including the learning curve, and all patients had well placed femoral and acetabular components at 2 year follow-up, with an average hospital stay of 1.7 days. All patients were placed in a comprehensive management program including preoperative medical optimization and counseling, as well as accelerated rehabilitation postoperatively. Of note, no IV narcotics were required or used in the postoperative period. Chow also reported 4 complications related to the surgery in the first 330 patients (1.2%) to undergo the operation, with 2 calcar fractures, 1 nondisplaced acetabular fracture, and 1 failure of cup fixation. [43,44]

Gofton et al reviewed 479 SuperPATH® patients across 3 centers and evaluated readmission and discharge disposition rates. There was an all-cause readmission rate of 2.3% after an average LOS of 1.6 days. 91% of patients were discharged home routinely, 3.8% home with home health,

and a combined 4.7% to skilled nursing and acute inpatient rehab facilities (4.1% and 0.6%, respectively). [41] Gofton then analyzed the cost reduction using these results compared to the patients receiving a THA via a lateral approach by another surgeon at the same institution and found a 28.4% cost reduction in favor of SuperPATH. [45]

Discussion

Overall, hip arthroplasty is a surgical procedure with excellent long term outcomes, no matter the approach, so long as the components are well-placed and well-seated. Each traditional approach has its pros and cons, which have been extensively studied and improved upon with better techniques and technology over the last several decades. Because of the consistent long-term results, increasing attention has been placed on short term recovery with accelerated rehabilitation programs, multimodal pain management, and tissue preserving approaches. Results of early attempts at minimally invasive THA were generally unacceptable; however, continued innovation and exploration of tissue-preserving intervals, including the ones discussed in this review, have resulted in promising short-term outcomes with consistent medium and long-term results.

It was previously thought that the DA approach showed accelerated recovery due to sparing the SER tendons in comparison to the traditional posterolateral approach. However, recent descriptions of the technique using conjoint tendon releases without compromises in outcomes [24] suggest that the SER preservation may not be the true source of improved postoperative pain. One possible explanation for the shorter recovery may be that the DA approach spares the proximal ITB at the greater trochanter. The ITB-sparing approaches described above, while differing slightly in dissection planes, preservation of SER attachments, and instrumentation, share the preservation of the ITB in common with the DA approach. The evidence showing that early postoperative pain and function are similar between the approaches suggests that the ITB preservation may be the key common factor.

Penenberg proposes that preservation of the ITB in this area preserves the gluteus maximus attachment at the ITB, and that the sparing of this attachment is what contributes to decreased pain and improved function in the early postoperative period (personal communication). This sparing of the ITB makes these approaches distinctly different from traditional posterior and mini-posterior approaches, as neither truly spares this portion of the ITB and the gluteus maximus insertion. The authors of this review concur with this hypothesis, although further biomechanical study

is needed to further define the role this structure plays.

When all is said and done, there is no conclusive evidence that one approach to THA is superior to another. The above-mentioned techniques offer different options to perform this common procedure in a manner that preserves the ITB and the insertion of the superior gluteus maximus. While the anterior approach is much more extensively studied, the learning curve and potential complications reported in the literature may deter surgeons from adopting the technique into practice. The other techniques mentioned here offer an alternative to the DA approach with promising short and medium-term results reported in the literature.

The decision on which approach to use in daily practice should be a function of the surgeon's training and experience. That said, the senior author of this review utilizes the PATH approach for the following reasons: 1) the ITB and gluteus maximus tendon sparing nature of the approach, which appears to influence early postoperative pain and function, 2) the small learning curve, likely due to the familiarity of the anatomy, approach, and orientation from a previously-used posterior approach, 3) the ease of use of the instrumentation introduced by this technique, 4) the extensile nature of the approach, should the need arise, allowing standard posterior approach access to the femur and acetabulum, and 5) the avoidance of common complications of the DA approach, such as LFCN injury, femoral perforation during broaching, and wound infections due to the incision being made in the groin area.

We recognize the need for increased clinical data to further demonstrate the safety and efficacy of these relatively new techniques. Longer term data is currently being collected. Further reporting of these results is warranted and merits discussion in the future.

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AUTHOR DISCLOSURES

The authors declare that there are no disclosures regarding the publication of this paper.

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